

We claim:

1. A composition suitable for cleaning, etching and dissolving alkaline earth metal fluoride crystals and optical elements made therefrom, said composition comprising a mineral acid and a fluoride ion sequestering agent.
2. The composition according to claims 1, wherein the mineral acid is selected from the group consisting of concentrated nitric acid, concentrated perchloric acid and concentrated hydrochloric acid.
3. The composition according to claim 1 wherein the fluoride ion sequestering agent is selected from the group consisting of boric acid, hypophosphorus acid and metaphosphoric acid.
4. The composition according to claim 1, wherein the mineral acid is concentrated nitric acid and the sequestering agent is boric acid.
5. The composition according to claim 1, wherein the concentration of the fluoride ion sequestering agent is in the range of 1-5.6% w/v.
6. The composition according to claim 4, wherein the concentration of the fluoride ion sequestering agent is in the range of 1-5.6% w/v.
7. A method of making a single crystal of an alkaline earth metal fluoride suitable for use in making <200nm optical elements, the method comprising the steps of:
 - providing an aqueous cleaning/etching composition comprised of a mineral acid and a fluoride ion sequestering agent;
 - providing an alkaline earth metal fluoride seed crystal;
 - cleaning/etching the fluoride seed crystal with the cleaning/etching solution and removing boron residues by washing with a dilute hydrofluoric acid solution;
 - providing a crucible suitable for growing metal fluoride crystals, the crucible having a reservoir at its bottom for receiving the seed crystal;
 - inserting the seed crystal into the reservoir wherein the cleaned and etched crystal is oriented along a selected orientation;

charging the crucible with a metal fluoride feed stock;
placing the charged crucible into a furnace suitable for growing metal fluoride crystals and heating the crucible containing the feedstock to melt the feedstock and the top part of the seed crystal; and
slowing cooling the melt so as to grow an oriented alkaline earth metal fluoride crystal having an <200 nm internal transmission of at least 90%/cm.

8. The method according to claim 7, wherein the cleaning/etching solution is comprised of:

- (a) one part concentrated mineral acid and
- (b) 0.5-7 parts a solution of a fluoride ion sequestering agent, wherein the sequestering agent is present in the solution at a concentration in the range of 3-7% wt./vol.

9. The method according to claim 8, wherein the sequestering agent is boric acid and the mineral acid is concentrated nitric acid.

10. The method according to claim 7, wherein the cleaning/etching is conducted at a temperature in the range of 30-175 °C for a time in the range of 30 minutes to 48 hours depending on the alkaline earth metal fluoride undergoing cleaning/etching, the temperature being greater and/or the time being longer in the order $\text{MgF}_2 > \text{CaF}_2 > \text{BaF}_2$.

11. A method of dissolving a single crystal of an alkaline earth metal fluoride or fragments thereof, the method comprising the steps of:

- providing an aqueous alkaline earth metal fluoride dissolving solution comprised of a mineral acid and a fluoride ion sequestering agent;
- providing an alkaline earth metal fluoride crystal or fragments thereof;
- dissolving said metal fluoride crystal or fragments thereof in said dissolving composition.

12. The method according to claim 11, wherein the dissolving solution is comprised of:

- (a) one part concentrated mineral acid and
- (b) 0.5-7 parts a solution of a fluoride ion sequestering agent, wherein the sequestering agent is present in the solution at a concentration in the range of 3-7% wt./vol.

13. The method according to claim 8, wherein the sequestering agent is boric acid and the mineral acid is concentrated nitric acid.

14. The method according to claim 11, wherein the dissolving is conducted at a temperature in the range of 50-250 °C for a time in the range of 1 hour to 5 days depending on the alkaline earth metal fluoride undergoing cleaning/etching, the temperature being greater and/or the time being longer in the order $\text{MgF}_2 > \text{CaF}_2 > \text{BaF}_2$.